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ABSTRACT

This guide is intended for use in teaching a course in the history of the development of transportation systems and the individual elements in such systems. The course is designed to break transportation systems down into their individual components so as to make it possible to study system types, media, technical elements, and environmental factors. The development and management of transportation systems and careers in the transportation industry are also explored. The first two sections discuss the guide's development within the framework of North Carolina's efforts to improve technological literacy and the guide's place as part of an instructional system. The purpose of the course and its main objectives are explained in the next section. An outline of the major topics addressed during the course is presented. The remainder of the guide consists of learning modules on the following topics: transportation's relationship to society, the government, and other technological systems; types of transportation systems; environmental media for transporting; technical systems in transportation; operation of transportation systems; and transportation and the environment. Each module includes information about the length of time needed to complete the module, an introduction to the instructional content to be covered in class, performance objectives, a day-by-day outline of student learning activities, and lists of suggested textbooks and references. (MN)

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ACKNOWLEDGEMENTS

The North Carolina Technology Education Curriculum is the product of a curriculum redirection process begun in the early seventies. As in any change process, many individuals have contributed their time and energies to provide North Carolina students with a curriculum designed to meet their needs to be technologically literate adult citizens. The following are recognized for their vision and leadership in setting the direction for Technology Education in North Carolina schools.

Members of the N.C. Curriculum Study Taskforce who charted the course for technology education in North Carolina schools. Their study report and recommendations provided the direction for a change in the identity of the discipline and a total redirection of the curriculum.

Members of the N.C. Curriculum Committee who validated the Technology Education Curriculum Guide as appropriate study for assisting students in understanding technological systems impacting on their lives. Further, industry representatives of the committee verified the appropriateness of suggested activities reflective of practices in construction, communications, manufacturing, and transportation.

N.C. Technology Education Association who provided a forum for redirection of the discipline. It was the association that led the profession in changing identity to technology education. The association also provided opportunities for professionals to develop competence in the classroom delivery of technology education through the sponsorship of in-service programs.

Individual technology education professionals who gave leadership to other professionals in the curriculum change process. These professional leaders piloted many technology education activities in their classrooms and served as role models for other professionals.

Members of the N.C. Council of Technology Teacher Educators who provided insite and support throughout the curriculum redirection process.

Indiana curriculum developers who provided curriculum materials adopted and adapted for North Carolina Technology Education programs.

INTRODUCTION

The North Carolina Technology Education Curriculum is a program to meet every citizen's need to be technologically literate. Some basic assumptions underlie the program, and these can be divided into content assumptions, and learner assumptions.

The curriculum was developed using the belief that the appropriate content for the field is technology, and its impact on individuals and society. It was further assumed that the content is best organized around human productive systems that have been used, are now being used, and will, most likely, continue to be used. These universal systems are communication, construction, manufacturing, and transportation. Finally, it was assumed that this content can best be addressed from a systems approach with its inputs, processes, outputs, feedback, and goals/restraints.

The curriculum was further based on the assumption that education should meet the needs of individuals and the human requirements of society. It was assumed that each person living in a technological society should have a basic understanding of and the ability to assimilate the knowledge about technology. People it was assumed, should be able to interact with the technological nature of society and help impact the type of future new technologies can provide. Additionally people should be able to be contributors to a society in their several roles, including citizen, voter, investor, consumer, worker, and leader.

These assumptions caused the curriculum to be developed in such a way as to:

1. Provide an overview of technology first, allow for more indepth study in specific technological areas, and culminate with synthesis activities.

2. Be more teacher-directed, content-centered in early courses, and highly, student-directed, process centered in advanced courses.

3. Involve problem-solving and group activities of all courses.

4. Stress the how and why of technology and its relationship to our quality of life.

5. Be activity-centered learning, with the content being used to determine the appropriateness of each activity selected.

6. Be equally important to young women and young men, both of which must function in a technological society.

Finally, the curriculum was developed to be descriptive rather than prescriptive. The materials describe what to teach and suggest ways of teaching the content. At no time are daily activities prescribed in such a way to preclude individualizing the presentations to meet local conditions.

THE CURRICULUM GUIDE IN AN INSTRUCTIONAL SYSTEM

Each course in the North Carolina Technology Education Curriculum is seen as a dynamic activity involving a complete instruction system. This system generally includes seven components: the teacher, the students, a texbook when available, the curriculum guide, laboratory sheets, apparatus, and a reference library.

THE TEACHER

The teacher plays the primary role in the system. This role entails being a curriculum developer. The teacher chooses the points to emphasize and to evaluate. Care should be taken to insure that the coverage of the subject is comprehensive. You should resist "picking and choosing" only modules and activities that are the most interesting, most familiar, or the easiest to implement. All modules and activities should be included. However, you are encouraged to redesign or replace activities with your own activities that contain equivalent content.

As a technical expert, the teacher gives presentations, demonstrations, and asks questions about the subject matter. Safety information, and the demonstration of teaching/learining activities, are the responsibility of the teacher.

The teacher is an instruction manager. Managers plan, schedule, direct, and control activities. The teacher, perhaps in cooperation with students, plan the instruction by identifying the instructional goals. The activities to reach these goals are scheduled. Through presentations and application activities students are directed through the construction activities. Finally, the student's work and the teacher's management is controlled through various forms of evaluation. Since evaluation instruments should be designed to measure success in reaching the goals, these instruments should be prepared by the teacher.

The teacher is the creator of the teaching/learning environment. It is highly recommended that you create a "role playing" environment. In addition to having students do tasks that simulate construction, have them play the role of workers, managers, and owners. For example, refer to a group of students as a "work crew" or "survey party" with job titles, rather than as students who carry out assigned tasks. Help them visualize themselves in their roles. The teacher can become a job superintendent, owner, or government officer, who approves the "work crew's" job.

THE STUDENT

The target population is made up of middle-junior high or high school students. The students will often work in groups of from three to five. Their responsibilities include reading the textbook assignments, doing the worksheets as homework, and completing the activities.

THE TEXBOOK

A textbook should be selected for the course and each student should have one. A textbook contains the body of knowledge about industrial technology. It should be selected to meet the appropriate reading level, and be written in an interesting way with numerous illustrations.

THE CURRICULUM GUIDE

The curriculum guide is to be used to help plan your instruction. The introduction consists of a structure for the content and a description of an instructional system with suggestions on how to use it.

The remainder of the curriculum guide briefly describes the modules. Each module consists of an introduction, objective(s), and a description of the activities. The description of the activities includes a schedule, presentation titles, application activities, and presentation titles, references, and safety guidelines. Suggestions for getting prepared and carrying out the activity are found in the teacher activity sections.

Suggestions for a variety of optional activities may also be found throughout the curriculum guide.

THE APPARATUS

Often the course guide contains plans for specialized apparatus useful in teaching the course. Drawings will be placed with the activity in which they are used. You can use the drawings to construct the apparatus.

THE REFERENCE LIBRARY

Some courses require student reference books. The titles of these are included in the reference library and copies should be purchased for laboratory use.

DAILY LESSON PLANS AND EVALUATION

The planning of daily activities and an on going evaluation system are th teacher's responsibility and rightfully so. Each student should adapt activities and presentations to insure they help students develop the identified concepts within local conditions. The curriculum guide was designed to help you, the local professional, present a relevant, exciting course. Good luck!

INTRODUCTION

Transportation devices and systems are as old as human life. From the earliest times, humans have had the need and/or desire to move themselves and their material goods from one point to another. This need has led to continual improvements and adaptions to transportation systems.

As humans improved their means of transporting, their world expanded and production increased. Civilization grew, too, from simple dwellings to thriving cities. The level of civilization, productivity, and societal structure are closely tied to each other and the available transportation systems. A change in one area leads to a change in all the others.

This course is designed to explore humankind's development of transportation systems and their associated components. The historical development of transportation is first explored. Ties with other areas of the culture are presented.

Once these background or foundational concepts are developed, the transportation systems are "taken apart" and the components of each system are studied. The major areas of study during this phase of the course are system types, mediums, technical elements, and environmental factors. Along with these factors, the development and managing of transportation activities are explored.

Finally, the careers in the transportation industry are presented. Career ladders and specific jobs are introduced.

All concepts in the class are reinforced through laboratory activities involving individual and group work.

OBJECTIVES

Upon completing this module, each student should understanding:

1. The need for and function of transportation in society.
2. Past, present, and emerging methods of transporting cargo and people.
3. The technical, social, and environmental aspects of transportation.
4. How to solve technical problems involving transportation.
5. The various careers available in the transportation industry.

TEXT AND REFERENCES

TEXT

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DeVore, Paul E., Transportation. Davis Publishing Company.

Karwarka & Kozak, Energy, Power, And Transportation. Harcourt Brace Jovanovich.

Shachet, Electric Vehicles.

Space Technology. Harmony Books.

The Future World Of Transportation. Walt Disney Productions.

The Timetable of Technology. Hearst Books.

COURSE OUTLINE

Module Number	Title and Content	Time (Days)
1	Introduction to Transportation Why transportation? Society and transportation Government and transportation Transportation and the other technological systems	5
2	Types of Transportation Systems The transportation system People transporting systems Cargo transporting systems Integrated transporting systems	10
3	Environmental Media for Transporting Transportation mediums Land transportation Water transportation Air transportation Space transportation	10
4	Technical Systems in Transportation Structural systems Suspension systems Energy sources and conversion Propulsion systems Guidance systems Control systems Support systems	42
5	Operating Transportation Systems Transporting operations Managing operations Development operations	10
6	Transportation and the Environment Transportation and the natural environment Transportation and the human-made environment	3

COURSE CONTENT

I. Introduction and History of Transportation Systems

- A. Historical Development
  - 1. Evolution with culture
  - 2. Application to need
- B. Social and Ecological Aspects
  - 1. Economics
  - 2. Environment/ecology
  - 3. Government
    - a. Controls
    - b. Subsidies
    - c. Tax incentive
  - 4. Social attitudes
  - 5. Community co-ops
- C. Relation to Manufacturing/Construction/Communication/Power and Energy
- D. Inventions
- E. Innovations
- F. Careers

II. Transportation systems

- A. Components
  - 1. Transporting operations
    - a. Receiving (people/materials and goods)
      - (1) People (personalized and mass transits)
        - (a) Terminal (multi-modal interface facility)
        - (b) Station (bi-modal interface facility)
        - (c) Random and fixed points
      - (2) Materials/goods (bulk, gross, packaged)
        - (a) Terminal (multi-modal interface facility)
        - (b) Warehouse (bi-modal receiving facility)
        - (c) Random/fixed points
    - b. Holding/Storing
      - (1) People (personalized and mass transit)
        - (a) Terminal
        - (b) Station (intermodal)
        - (c) Random/fixed points (intra-modal)
      - (2) Material/goods (bulk, gross, packaged)
        - (a) Terminal
        - (b) Warehouse
        - (c) Random/fixed points

c. Loading (people/goods/materials)
   (1) Manual
   (2) Mechanical (manually operated)
   (3) Mechanized
      (a) Semi-automated
      (b) Automated
   (4) Hybrid
d. Unloading
   (1) Automated/mechanized
   (2) Manual/mechanized
   (3) Manual
   (4) Hybrid
e. Delivering
   (1) Means of delivering to final destination
      (a) Self-locomotion
      (b) Fixed route to random
      (c) Check-in/receiving
   (2) Managing Operations (people/goods/materials)
      (a) Planning
      (b) Organizing
      (c) Directing
      (d) Controlling
      (e) Evaluating
      (f) Improving/updating
   (3) Development Operations (people/goods/materials)
      (a) Planning
      (b) Designing
      (c) Building
      (d) Maintaining
      (e) Evaluating/updating

B. System Types
   1. People
      a. Personalized (individual)
         (1) Random route
         (2) Fixed route
      b. Mass Transit
         (1) Random route
         (2) Fixed route
   2. Materials and Goods
      a. Natural forms of movement
      b. Technologies of transport
         (1) Containers
         (2) Vehicles
         (3) Terminals
         (4) Pathways

C. Environmental Mediums
  1. Terrestrial Modes and Systems
    a. People
      (1) Human locomotion
      (2) Carts and wagons
      (3) Railways
        (a) Conventional surface rail
        (b) Subsurface rail
        (c) Elevated rail
        (d) Trolley rail
      (4) Personal rapid transit
      (5) Bicycle
      (6) Motorcycle
      (7) Automobile
      (8) Bus
      (9) Snowmobile
      (10) Special purpose
        (a) Elevators
        (b) Escalators
        (c) Moving sidewalks
      (11) Tube transportation
      (12) Multi-system
    b. Materials and goods
      (1) Railway
      (2) Truck
      (3) Continuous capacity systems (stationary)
        (a) Conveyors (mechanical/pneumatic)
        (b) Pipelines
        (c) Multi-systems
  2. Marine Modes and Systems
    a. Inland waterways
      (1) Canals
      (2) Rivers
      (3) Lakes
      (4) Coastal
    b. Transoceanic
      (1) Canals
      (2) Oceans
    c. Marine modes
      (1) Personal/mass
        (a) Canoe
        (b) Powerboat
        (c) Sailboat
        (d) Raft
        (e) Ocean liner
        (f) Other

(2) Goods and materials
(a) Canoe
(b) Barge
(c) Freighter
(d) Other
(3) Special purpose
(a) Hydrofoil vessel
(b) Hovercraft vessel
(c) Submarine
(d) Other

3. Atmospheric Modes and Systems (people and goods)
a. Lighter-than-air
(1) Rigid airship
(2) Semi-rigid airship
(3) Balloon
b. Heavier-than-air
(1) Conventional aircraft (passenger)
(2) Helicopter
(3) Military aircraft
(4) Special purpose aircraft
(5) Cargo aircraft
4. Space Modes and Systems
a. Manned space vehicles
(1) Spacecraft (civil)
(2) Space shuttle
(3) Space station
(4) Spacecraft (military)
b. Unmanned space vehicles
(1) Missiles
(2) Launch vehicles
(3) Satellites
(4) Space probes
5. Interrelated Systems
a. Interface areas
b. Multi-purpose
c. Hybrids

D. Technical Systems
1. Propulsion Systems
a. Energy sources
(1) Exhaustible
(2) Inexhaustible
(3) Renewable

b. Conversion systems
   (1) Internal combustion
   (2) External combustion
   (3) Hybrid systems
      (a) Mechanical/mechanical
      (b) Chemical/chemical
      (c) Electrical/mechanical
      (d) Chemical/electrical
c. Transmission systems
   (1) Mechanical drive system
   (2) Hydraulic drive system
   (3) Electric drive system
      (a) Generator/motor (rotary)
      (b) Linear induction
   (4) Vacuum
   (5) Gravity
   (6) Reaction
      (a) Water jet
      (b) Air reaction
      (c) Rocket (liquid/solid)
   (7) Storage devices

2. Suspension Systems
   a. Mechanical suspension
      (1) Wheel on surface
      (2) Wheel on rail
      (3) Wheel on guideway
      (4) Monorail systems
      (5) Sliding devices
   b. Fluid suspension
      (1) Aerostatic lift
         (a) Air cushion
         (b) Air film
      (2) Hydrostatic
      (3) Hydrodynamic
         (a) Foil
         (b) Lift
      (4) Aerodynamic
   c. Magnetic suspension
      (1) Permanent magnet
      (2) Electromagnet

3. Control Systems (degrees of freedom)
   a. Velocity control
      (1) Acceleration
      (2) Deceleration
      (3) Breaking
   b. Directional control
   c. Attitude control
   d. Altitude control
   e. Vehicular and system control
      (1) Manually
      (2) Remotely
      (3) Regulatory
4. Guidance Systems
   a. Guideway systems
      (1) Highway
      (2) Rail flange
      (3) Tube
      (4) Canal
      (5) Cable
      (6) Monorail
   b. On-board and external guidance devices/systems
      (1) Sensing systems
      (2) Encoding systems
      (3) Transmitting systems
      (4) Signalling systems
      (5) Receiving systems
      (6) Decoding systems
      (7) Storing systems
      (8) Retrieval systems
   c. Interrelationship of guidance and control systems
5. Structural Systems
   a. Vehicular - design considerations
      (1) Human factors
      (2) Safety
      (3) Environmental
      (4) Performance
      (5) Economic factors
   b. Guideway structures - design considerations
      (1) Railways
      (2) Monorails
      (3) Cableways
      (4) Beltways
      (5) Roadways
      (6) Bridges
      (7) Tunnels/canals
      (8) Airport runways

c. Support systems - structures
(1) Terminals
(2) Maintenance/service
(3) Roadside rest areas
(4) Harbors
(5) Loading/unloading docks
(6) Storage facilities
(7) Parking lots and ramps

6. Support Systems
a. Physical facilities - design factors
(1) Ticket offices/reservations
(2) Harbors/docks
(3) Parking facilities
(4) Intermodal interfaces
(5) Baggage handling
(6) Other
b. Personnel
(1) Selection
(2) Training/education
(3) Career opportunities
(4) Economic factors
c. Systems regulatory factors
(1) Laws and regulations
(2) Licensing
(3) Enforcement
d. Operational systems
(1) Traffic management
(2) Scheduling
(3) Routes and routing

III. Environmental Factors

A. Human/Social
1. Safety
2. Human values and desires
3. Enhancement of social, recreational, cultural programs and facilities
4. Comfort/convenience
5. Demand Responsiveness
6. Service for handicapped and elderly
7. Privacy

B. Economic/service
   1. Transportation costs
   2. Access to employment opportunities
   3. Efficiency
C. Physical and Functional
   1. Effects on land use
   2. Adaptable to future needs
   3. Flexibility
   4. Adaptable to intermode operations
D. Aesthetics
   1. General appearance in relationship to surroundings
   2. Environment
   3. Conversation of natural resources
E. Interrelated
   1. Level of noise
   2. Air and/or water pollution characteristics
   3. Neighborhood growth and development
   4. Accessibility
F. Ecological
   1. Pollution
   2. Preserving the environment
   3. Conservation

MODULE: 1 : Introduction and History of Transportation Systems

LENGTH: 5 DAYS Transportation CLUSTER

Transportation devices and systems are as old as man himself. From the earliest times, man has had the need to move goods, materials, and people from one place to another. As man's society and civilization grew and improved, so did his transportation. And, as he improved his means of transportation, his productivity, and civilization also improved. It is this close tie and co-development which this module focuses on. The development of various transportation systems, their interaction in and with our society, and their inherent problems are studied. Students also address the social and ecological aspects of transportation systems in the area of economics, environment/ecology, government influences, social attitudes, and community co-ops.

The purpose of this module is to develop a basic understanding of the "Hows" and "Whys" of transportation systems and to lay a basic foundation for the rest of the course to build upon.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Explain man's need for transportation systems.
2. Explain how transportation systems have evolved with culture.
3. List three basic ways the government has input into transportation systems.
4. Explain how social attitudes affect transportation systems.
5. List four ways the environment and transportation are related.
6. Explain how transportation systems relate to manufacturing, construction, and communication.
7. Explain the importance of power and energy to transportation.

CALENDAR

DAY	ACTIVITY
1	Complete the administrative tasks to start the class.
2	Present the course outline and objectives. Present and illustrate: A. Transportation Systems 1. Historical development 2. Social/ecological aspects 3. Relation to other industries 4. Inventions/innovations. Show a film on historical aspects of transportation. Assign timeline research.
3-4	Student lab work time on research for timeline and model building. Go over machine use and safety.
5	Student presentations of timeline research and models. Review outcomes and results.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Well before this module is introduced, the following tasks should be completed: 1. Order and preview an appropriate film or video on the historical development of transportation for Day 1. 2. Develop timeline activity guidelines handout. (See Appendix for sample.)
1	Complete the necessary administrative details to start a class.
2	Present the course outline and objectives. Describe the various areas that will be studied and typical activities which will be completed during the class. BE A CHEERLEADER!!! Present a lecture and discussion on: A. Historical Development 1. Evolution with culture 2. Application to need B. Social and Ecological Aspects 1. Economics 2. Environment 3. Government influences 4. Social attitudes 5. Community co-ops C. Relation to Other Industries 1. Manufacturing 2. Construction 3. Communication 4. Power and energy D. Inventions E. Innovations F. Careers. Show film on transportation development. Assign students dates on timeline to research. Discuss tool use (power and hand) and safety. Make sure students understand and follow the safety procedures.

DAY	ACTIVITY
3-4	Students are to research assigned time period and write a 2-3 page report on a specific transportation device or system used during that time period. Include in this report personal thoughts on: 1. How has transportation affected my life? 2. In what ways have I affected transportation? 3. What changes have I seen take place in transportation? 4. In what ways has transportation changed my environment? Good or bad? Using the information researched, students are to design and build a model of the device or system they picked. This model should be as accurate as possible and relate the actual use and application of the device or system. This model does not have to actually operate (i.e. model car) but should be realistic. Any available materials may be used, but model MUST be student-built and assembled.
5	Students make class presentations of research and model. A brief written report along with the model should be turned in. Students should also fill in and point out on the master timeline (posted on wall) their time period. Review with class the timeline and relate it to the social development of man and his culture.

TIMELINE ACTIVITY GUIDE

Student Name: _____

Period: _____

Date: _____

Time Period Assigned: _____

References:

_____ Pg.No. _____

_____ Pg.No. _____

_____ Pg.No. _____

_____ Pg.No. _____

_____ Pg.No. _____

_____ Pg.No. _____

Transportation System:

Type	Inventor	Date

Questions to Answer:

1. How has early transportation affected current types?
2. What created changes in transportation?
3. How has transportation affected society? (Good and Bad)
4. How has transportation affected the environment? (Good and Bad)
5. What changes have I seen take place?

BIBLIOGRAPHY

VIDEO

Remember When, T.V. Series, Wheels, Wings, and Whistles shows historical development of the United States.

SLIDES

Slide series (200+ slides) in Ball State Library showing history of transportation (wagons to moon landings).

MODULE: 2 : Types of Transportation Systems

LENGTH: 10 DAYS Transportation CLUSTER

All transportation systems can be categorized as one of two major types. These two major types are:

1. People transporting
2. Material/goods transporting.

As can be seen, this classification is based on what type of "material" is being transported. Different transporting, managing, and developing operations must take place depending on the type of system.

These two major areas can in turn be broken down into even more specific areas according to the actual method of transporting taking place. These areas consist of the following:

A. People
   1. Personalized/individual
   2. Mass transit.
B. Materials/goods
   1. Natural forms of movement (pouring, sliding, etc.)
   2. "Technologies" of transport (conveyors, containers, etc.).

The emphasis should be placed on analyzing and exploring as many different forms of transporting as possible and breaking them down into their particular groups.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. List and explain the two major transporting system categories.
2. Explain how systems are classified.
3. List and explain the breakdown of the two major categories.
4. Explain how new "technologies" in transportation are developed.

CALENDAR

DAY	ACTIVITY
1	Present a lecture and discussion on: A. People systems 1. Personalized 2. Mass transit. B. Material and goods systems 1. Natural form of movement 2. Technologies of transport.
2	Film, slides, guest speaker on systems.
3-9	Have students design and build a model of assigned transportation system type.
10	Have students present models and research. Review and discuss model.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Prepare discussion materials. Develop and/or arrange transparencies. Arrange a field trip and guest speaker Lecture and discussion on: A. People Systems 1. Personalized/individual 2. Mass transit. B. Material/goods Systems 1. Natural forms of movement 2. Technologies of transport. When discussing systems be sure to bring out all types of systems, i.e. elevators, escalators, moving sidewalks, etc. for people systems, conveyors, bucket wheels, pipelines, troughs, etc. for material/goods systems. "Technologies of Transport" refers to those systems which are specially designed to transport a given material/goods. Special containers, handling systems, transport devices are examples of technologies of transport.
2	Show a film, have a guest speaker, or take a field trip to help reinforce the concepts covered. Randomly assign students one of the four basic transportation systems (personalized, mass, natural forms, and technologies); the model of any design which fits their assigned system.
3-9	Students begin designing and building a model of their assigned transportation system type with some thought given to the efficiency of the system, cost of the system, application of the system, social attitude toward the system, and cultural influences on the system. The models should be operational and demonstrate the concepts of that particular system. Neatness and quality of work should also be taken into consideration.
10	Have student presentations of models. The students should give system type, explain its operation and function, and give advantages/disadvantages of system. Review system types and discuss observations and findings from models. Some concepts which should be covered are the energy efficiency of systems, the cost of systems, social attitudes toward systems, the cultural influences on systems, and the application of systems.

MODULE: 3 : Environmental Media For Transporting

LENGTH: 10 DAYS Transportation CLUSTER

All transportation systems are designed to operate in one or more mediums. There are four different mediums and one combined area of operation. These areas are land, water, atmospheric, space, and interrelated.

These five areas can then be broken down into basic elements according to the system type (people or material/goods), and the subsystem type (car, train, truck, conveyors, etc.).

The major emphasis should be on the design and the development of various types of transportation systems in different environmental mediums. Problems and possible solutions should be addressed by exploring different mediums of operation for a given solution.

The interaction and interface of transportation systems from different mediums should be explored and discussed. All transportation systems, regardless of medium or operation, interface with at least one or more other systems. This interaction can be a direct link or an indirect link. By studying these ties, students can explore the chain reaction of different problems.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. List and explain the five basic mediums of transportation.
2. Explain how the "system type" regulates medium use.
3. Develop solutions to transportation problems using various mediums.
4. Explain how different systems interface.

CALENDAR

DAY	ACTIVITY
1	Present a lecture and discussion on: 1. Land modes and systems 2. Water modes and systems 3. Atmospheric modes and systems 4. Space modes and systems 5. Interrelated modes and systems. Have students begin bringing in pictures to develop display boards of different modes (done throughout module).
2	Small group assigned a mode to work in.
3-9	Small group begins lab work designing, developing, and building models of assigned modes.
10	Groups present solutions and models by giving the following information: 1. Design rationale 2. Requirements met 3. Device or vehicle. Review and discuss solutions and observations made.

DAY	ACTIVITY
0	Prepare discussion materials, worksheets, handouts, etc. as needed. Develop and/or arrange visuals.
1-2	Discuss the wide variety of systems under each type and how they evolved and relate to each other. The differences between the types of systems and their specific requirements should also be explored. Present a lecture and discussion on: A. Land Modes and Systems 1. Roadway 2. Rail 3. Pipeline. Discuss how these systems are interrelated and the individual differences and similarities. It should also be noted how some goods/materials may dictate the use of a given system in spite of costs or disadvantages of that particular system. B. Water Modes and Systems 1. Inland waterways 2. Transoceanic 3. Marine modes (personal/mass, goods/materials, special purpose). Discuss the three basic areas of marine operation and the importance of each. It should be noted that water transportation (floating something downstream) is one of man's oldest forms of transportation and has probably had the greatest impact in discovering and developing our world. C. Air and Space Modes and Systems (people and goods) 1. Lighter than air a. Rigid airship b. Semirigid airship c. Balloon. 2. Heavier than air a. Conventional aircraft (passenger) b. Military aircraft c. Special purpose aircraft d. Cargo aircraft. Discuss the two basic categories of atmospheric systems - lighter than air and heavier than air, and their sub-elements. Discuss uses (past and present), applications, advantages, and disadvantages of each sub-element.

DAY | ACTIVITY

D. Space Modes and Systems
   1. Manned space vehicles
   2. Unmanned space vehicles

Discuss the two types of space systems and how the systems are similar in some ways and different in others. The interaction of these two system types should be emphasized and the importance of their influence on each other.

E. Interrelated
   1. Interfacing
   2. Multipurpose
   3. Hybrids

Discuss how the systems/modes interface and the resulting problems. This interfacing can be a positive factor (i.e. taxis and airports), or become major problem areas (i.e. railroad crossing traffic). Also, there are some systems which have more than one purpose or area of operation (the space shuttle is both space and air system), or which are developed to operate in a special environment (like a hovercraft).

Divide the class into groups of 2-4. (You will need at least four groups.) Assign groups an environmental mode (land - rail, roadway, pipeline; air - lighter-than-air, heavier-than-air; water - ocean, inland waterway; space.) Have each group design a system for the mode, and build a model of the system.

Students are to design a model of a transportation system. The specific type will depend on which is assigned by the instructor. The model should be functional and demonstrate the concepts of transportation systems. The following considerations should be addressed and included in the final presentation to the class:

1. Function of system
2. Design factors
3. Limits of system
4. Efficiency of system
5. Interfacing with other systems.

Models will be tested to determine how they relate to the above considerations and their actual operation.

Have students develop display boards by bringing pictures of various systems.

DAY	ACTIVITY
3-9	Students are to start building a model of their transportation system. Demonstrate tool and machine use and supervise student work on lab activity.
10	Students present their models to the class and highlight/explain the following: 1. Operation 2. Function 3. Design factors 4. Possible interfacing. Models are tested according to the students' design factors and functions and evaluated for use, efficiency, and interfacing. (Wind tunnel testing of some vehicles would be possible.) Review and discuss observations made during presentations and testing.

MODULE: 4 : Technical Systems In Transportation

LENGTH: 42 DAYS Transportation CLUSTER

All transportation systems are made up of basic technical systems. These technical systems are:

1. Propulsion systems
2. Suspension systems
3. Control systems
4. Guidance systems
5. Structural systems
6. Support systems.

Without the interaction of these six systems, transportation systems cannot operate. Each form of transportation has some specific element from each of these technical systems. The amount of influence each element has, and its relative importance, depends on the type and medium of system being studied.

Within each of these six elements, are the components which make up the technical systems. Not all of these smaller components are in each form of transportation. Again, it depends on the specific transportation system being studied as to what is applied.

During this module, transportation systems will be analyzed according to the technical elements and their influence/importance to the particular system. A comparison of different systems and their similarities and differences in technical systems should also be discussed.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. List and explain the six technical systems.
2. Explain how the technical systems are related to transportation systems.
3. Analyze a given transportation system and list its technical elements.
4. Develop a transportation system using the six technical elements.

CALENDAR

DAY	ACTIVITY
1	Lecture and discussion on: 1. Introduction of transportation systems 2. Structural systems 3. Suspension systems.
2-7	Lab time for student work.
8	Lecture and discussion on: 1. Control systems 2. Guidance systems.
9-14	Lab time for student work.
15	Lecture and discussion on: 1. Propulsion systems 2. Support systems.
16-26	Lab time for student work.
27	Review results. Divide class into small groups which will design, develop, and build a transportation device that meets given requirements.
28-41	Lab time for group work.
42	Student presentations and testing of devices. Discuss design and development operations. Discuss and review observations and results.

DAY	ACTIVITY
0	Prepare discussion materials, worksheets, handouts. Develop and/or arrange visuals.
1	Present a lecture and discussion on: A. Introduction of transportation systems 1. Historical development 2. Social aspects 3. Ecological aspects 4. Relation to other industries. This should be a general overview of transportation systems. It should highlight the development, importance, and social impacts of transportation systems. There should also be a review of the different components which make up transportation systems and an introduction to the technical elements. Lecture and discussion on: B. Structural systems 1. Vehicular (moving) 2. Structures (fixed). This should cover the two basic types of structural systems - moving vehicular and fixed structures. The interaction and importance of each should be emphasized along with its purpose(s). C. Suspension systems 1. Mechanical 2. Fluid 3. Magnetic. The basic concept of a vehicle's suspension to support the weight of the vehicle while allowing for the movement and the vehicle - should be emphasized and discussed. The three basic forces which are used to achieve this end should also be discussed. A variety of transportation systems/vehicles should be analyzed to their specific suspension system and its operation.

DAY	ACTIVITY
2-7	Students should bring in pictures of systems to develop display boards.

Develop an activty which will highlight the structural and suspension components of a transportation device/vehicle.

Some possible activities are:

1. Build a rubberband-powered airplane from a kit or "scratch."

   (Midwest Products have class sets, as well as local hobby shops.)

2. Design and build a cable car system across the room to carry golf balls.

3. Design and build a conveyor/sorting machine for gravel. Machine must transport material and sort it out by size.

4. Design and build a model of a hot air balloon.

8 Lecture and discussion on:

A. Control systems
   1. Velocity
   2. Directional
   3. Attitude
   4. Altitude
   5. Vehicular and system.

Control systems are those elements which allow for changes in a vehicle/system - velocity, direction, attitude, and altitude. There are two basic categories of control - system traffic control and vehicular control. System traffic control regulates the flow of a system (traffic light system for automotive traffic), while vehicular control, includes on-board components to vary its movement.

B. Guidance systems
   1. Guideway
   2. On-board/external devices/systems
   3. Interrelationship or guidance and control

DAY	ACTIVITY

Guidance systems are the link of human to machine for controlling direction. This direction is along a specific path and becomes more complex in control as the amount of "freedom" is increased. Those elements which deal with guidance like guideways (roads, rails, etc.) are also included in this area. The environment in which the system operates also dictates certain design considerations in guidance systems.

Each of these areas should be explored and discussed by looking at various systems in operation. Component similarities and differences should be noted and their interaction in each specific area or system.

Students bring in pictures for display boards.

9-14 Develop an activity which will highlight the control and guidance systems of a transportation device/vehicle.

Some possible activities are:

1. Design and develop a vehicle which will travel down a stairway handrail (or set guideway structure). Materials and size can be regulated by the instructor.

2. Design and build a control system to guide a given vehicle (boat, car, etc.) through a given path or maze. Different systems can be applied depending on materials and equipment available (i.e. radio control, hard wire, light/laser, guide wire, etc.).

3. Design and build conveyor system which will regulate the "flow" of products or materials down the line (i.e. size, shape, quantity, spacing, etc.).

4. Build a "robot" from one of the available kits or from plans in books like:

   How to Make Computer-Controlled Robots. Osborne.

   How to Build Your Own Self-Programming Robot. Heiserman Tab Books.

DAY	ACTIVITY

15 Lecture and discussion on:

A. Propulsion Systems
   1. Energy sources
      a. Exhaustable
      b. Renewable
      c. Inexhaustible
B. Conversion Systems
   1. Mechanical drive
   2. Hydraulic drive
   3. Electric drive
   4. Vacuum
   5. Gravity
   6. Reaction
C. Storage Devices.

Students should be introduced to the concepts of limited energy sources and conversion. The application of energy to transportation systems and devices should be the major emphasis with discussion and analysis of various systems. The connecting of the energy source to a drive system with resultant movement is the purpose of the propulsion system. An engine or motor, transmission, pulley, belt, fluids are all elements in propulsion systems. The specific elements used and interfaced depends on the particular transportation system. Various transportation systems should be studied and their propulsion systems (and elements) discussed and compared.

Students bring in pictures for display boards.

D. Support Systems
   1. Physical facilities
   2. Personnel
   3. Regulatory factors
   4. Operational factors.

16-26 Develop an activity which will highlight the propulsion and support systems of a transportation vehicle/device.

Some possible activities are:

1. Small 3-4 HP engine tear down and rebuild. (This is to learn about engines and NOT to teach small engine repair.)

DAY	ACTIVITY

2. Test various engines on a dynometer and compare results. Test could include fuel types, compression ratios, air/fuel mixtures, loads, speeds, temperature changes, etc. (CITE project has plans for a simple Dyno.)

3. Using syringes and plastic tubing develop hydraulic and pneumatic systems. (The syringes act as the cylinders, the tubing transmits the fluid or gas between them.)

4. Build a "space can" model of Hero's steam turbine. Solder or epoxy tubes in a can pointing in opposite directions. Hang the can by a string and heat the water inside with a propane torch. Steam will cause it to spin.

5. Design and build a propulsion system to power a given vehicle. Size, fuel, power, and materials can be regulated by instructor.

27 Divide class into small groups of 3-4 students. These groups are to work as a development team.

Assign teams a specific element from each of the following:

1. System medium (terrestrial, marine, atmospheric, space).
2. System type (people-personalize/mass, materials - natural/technological).
3. A sequence number from one to the total number of groups. This is the order in which devices must work together.

Give groups a problem statement for them to solve and specific requirements to meet. This statement should be as follows:

"Design, develop, and build a transportation device, vehicle, or system which will move/transport the passenger (raw egg) a total of 6 feet (linear, vertical, or combination), and transfer it to the next system. This device/vehicle system must be made by the group and take full advantage of their given medium and type."

Other requirements could be added:

1. Specific types of materials
2. Time in transport
3. Size
4. Power source.

DAY	ACTIVITY
28-40	Working in small groups as development teams, the students should read through the problem statement and list all the design considerations and requirements. They should assign jobs and duties to each member - development operations - and begin research. Following the given problem requirements, they are to design, develop, and build a transportation device/vehicle from the assigned system type and medium. The development of the interface between the devices must be worked out between the groups. Groups must work together in order to create a workable "system." Individual devices are to be put together and the "system" set up. The system is then run by the groups with observations and results being recorded.
41	Students are to write and turn in individually a report on their activities and results. This report should include: 1. Areas of work 2. Actual duties in activity 3. Problems encountered 4. Interfacing problems 5. Personal observations.
42	Discuss and review observations and results. Bring out the concepts of: 1. System interaction 2. "Flow" through system 3. Interfacing problems 4. Development operations 5. Managing operations 6. Transporting operations. Discuss design and development problems both within and between groups.

MODULE: 5 : Operating Transportation Systems

LENGTH: 10 DAYS Transportation CLUSTER

When transporting people, materials or goods there are specific activity areas which must take place. These activity areas can be divided into three major groups. These groups are classified as transporting operations, managing operations, and development operations.

The extent to which each of these operations are used depends on a wide variety of factors. Such things as system type, medium of operation, "material" being transported, and purpose of transporting, all influence the amount of activity in each area.

The major emphasis should be placed on developing an understanding of these basic operations and their inclusive activities, methods and interaction. Since transportation is the moving of people, materials or goods, from point A to point B in the most efficient method possible, then the discussion and development of different system types and mediums can be better understood when the basic operations are understood. If a transportation system is to continue to remain operational, efficient, and profitable, then the managing and developing operations must continually be applied and worked through. Many of these activities are seldom actually seen; they are pencil/paper work done in an office. However, it is this area of activity which maintains and operates the whole of the transportation systems. The interrelationships of the different areas and activities should be looked at and discussed. The overlapping of the activities or operations should be stressed along with the concept that one area is more or less important, or can work outside of the other two. This is the team concept now being used by industry to strengthen their product and work force.

The major emphasis of this module is the "managing" activities which take place in order for the transportation system to work properly. These activities are developed, discussed and studied by a series of role-playing situations. The more interaction and depth that is developed the better the learning experience will be.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. Explain what activities take place during the transporting operations.
2. List the two basic types of systems and how they affect the operation activities.
3. List four factors which influence transporting operations and explain why.
4. Explain the activities which take place during the managing operation.
5. Explain how management operations are related to transporting operations.
6. Explain how different transporting problems are addressed and solved by management.
7. Explain what activities take place during development operations.
8. Explain the tie between the three areas of transporting operations, managing operations, and development operations.

CALENDAR

DAY	ACTIVITY
1	Present a lecture and discussion on transporting operations, managing operations, and development operations.
2	Assessing role-playing jobs, student research, and then role-play job positions.
3-9	Set up transporting industries using each area (transporting, managing, developing) and have student businesses compete in market.
10	Group presentations and interaction.
	Review and discuss what went on and results/outcomes observed.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Prepare discussion materials, worksheets, handouts. Develop and/or arrange transparencies. Arrange for a guest speaker or a possible field trip.
1	Present a lecture and discussion on: A. Transporting Operations 1. Receiving a. People b. Materials/goods 2. Holding/storing a. People b. Materials/goods 3. Loading a. People b. Materials/goods 4. Unloading a. Automated/mechanized b. Manual/mechanized c. Manual d. Hybrid 5. Delivering a. Self-locomotion b. Fixed route to random c. Check-in/receiving. B. Managing Operations 1. Planning 2. Organizing 3. Directing 4. Controlling 5. Evaluating 6. Improving/updating. Discuss tie between transporting and managing operations. C. Development Operations 1. Planning 2. Designing 3. Building 4. Maintaining 5. Evaluating/redesigning 6. Improving/updating.

DAY	ACTIVITY

2 Assign role-playing jobs to different students. Discuss and explain as a class, the duties and responsibilities of each job. Some of the possible management jobs are:

1. Dock foreman
2. City road planner
3. School transportation director
4. Maintenance supervisor
5. Airline route planner
6. Control center (space)
7. Claims adjuster, etc.

Once jobs are assigned, present problem to student "management." Allow 5-10 minutes for individuals to read through and develop some thoughts such as:

1. Their job "stance" on the issue
2. Their relationship to the problem
3. Their immediate action(s) to be taken
4. Their long-range action(s) to be taken
5. Person/area at fault
6. Possible compromises you could make.

Begin discussion/role-playing by reading problem aloud to class. Those persons involved may begin responses. Some possible problems could be:

1. Planners deciding new route; several choices- each pushes for his own.
2. Lost or damaged goods - customer vs. management.
3. Streamlining system and cutbacks in number - management vs. labor

Review outcomes and observations of activities.

Bring out observations made, feelings during role playing, "job stress," and group interaction.

Discuss how possible current issues may be dealt with or are possibly being dealt with.

Discuss "no win" situations and "limited loss" arguments.

Have guest speaker present job descriptions and activities. Have them address some of the problems and observations of the students.

DAY	ACTIVITY
3	Hand out development problem worksheets. These development problems should cover a variety of situations and systems. Local situations and problems should be presented. Typical problem statements should follow this format:

"The local city/town board is wanting to expand the mass transit system. The current system is outdated and public use is very low. The new system will cost several million dollars to set up, but could bring a large profit with public use."

Working in small groups (3-4) students, read through the problem statements assigned. Remember they are a development "team" working on this as industry would. They should take into consideration such ideas as:

1. Environmental impact
2. Gains vs. losses
3. Private interests/rights
4. Profitability
5. "Selling" idea to public
6. Government regulations/controls.

Some problems may not be solved simply or without forming more problems. Groups should try to work out as many problem areas as possible — deals, compromises, and program cuts may be necessary.

4 Group presentations of development problem/solutions. The issues and considerations should be presented along with compromises, cuts, etc. made.

Groups should interact and discuss each group's rationale for decisions. Alternate solutions could be brought out and discussed.

Review outcomes of group work and discuss procedures used to arrive at solution. Discuss ideas of public right-of-way, compromise, laws of "eminent domain", and public progress vs. individual rights.

Have guest speaker address some of the problem statements students work through. Have them give job descriptions and activities of their profession.

Allow time for student interaction and discussion.

DAY	ACTIVITY
5	Divide class into three or four groups. These groups are to pick a transportation industry in which they become the developing, managing, and transporting operations. Set up a given situation involving the use of transportation (i.e. new sports center, inner city development, interstate transport needed), in which the industries are to try and meet the demand and "win" the contract. Teacher can be "government" and add on regulations and controls. Industries can compete, bargain, merge, etc. in order to gain control. Set up one group as the "board" with the transportation situation. They will be the group that the industries try to influence. NOTE: Government controls may be added at any time. Upon receiving the transportation situation from the instructor (all groups get the same), groups should complete the following: 1. Decide if their particular industry or system can efficiently and profitably meet the need. 2. If "yes" begin planning development of system. Remember to look at it from all angles and perspectives. Answer: How, When, Where, Cost, etc? 3. If "no" decide how they can become competitive. Possible business deals should be looked at — mergers, partnerships, etc. Also, look at possible expansion plans. All information and notes are to be recorded in individual notebooks.
6	Round #1 Each group makes an initial bid for the project explaining their ideas (rough). Each group may also take option of passing on first bid. "Board" accepts bids for consideration, only, pending final presentations.

DAY	ACTIVITY
7	Round #2 Industries begin detail planning of project - routes, time frame, etc. Industries may also begin dealing with each other (merge, partnerships, etc.). NOTE: Teacher may impose "government" controls at any time. "Board" looks over all proposals and "replies" to each bidder with requirements and specifications.
8	Round #3 Industries present detailed plans of their transportation systems. Included are: 1. System type 2. System impact (social/ecological) 3. Land (private or public) needed 4. Interfacing with current systems. Board looks through plans and either award project or calls for more information. If board wants to award contract, bidding industries may "deal" for best position. If the board calls for more information, then industries go back and rework bid and plans.
9	Round #4 Industries present final "deal" and project. Detailed information is needed along with plans and drawings for proposal. Again, the following should be included: 1. System type 2. System impact (social ecological) 3. Land use (private/public) 4. System interfacing. "Board" must now award bid to one industry (giving reasons and rationale for decisions) or declare no award, due to: (must list reasons, i.e. none meet specs, too high impact, etc.).
10	Review and analyze what took place during role game. Pull out problem areas observed, group interactions, and system breakdowns. Reinforce the concept of "system" (all three operation areas working together). Also, highlight complexity of some "simple" transportation problems.

MODULE: 6 : Transportation and the Environment

LENGTH: 3 DAYS Transportation CLUSTER

Our society has begun to take concern, and rightly so, of those things which can and do effect our environment. Many industries and products create some form of environmental impact, but none seem as obvious to the public as transportation systems. Because of their vastness and widespread use, transportation systems, vehicles, and devices have come under increasing observation and regulation in this area.

The purpose of this module is to introduce and address the environmental impacts of transportation systems. These areas of concern are:

1. Human/social
2. Economic/service
3. Physical and functional
4. Aesthetics
5. Interrelated
6. Ecological.

As you can see the environment is seen as our total surroundings and not just "nature." Although the most widespread concern of the public is nature-type impact, there are many other areas which often times go unnoticed. These areas should be emphasized and discussed, and the many complicated aspects and issues looked at. Although no immediate solutions will be started, students can begin a responsible look at what could be and should be done.

OBJECTIVES

Upon completing this learning module, each student should be able to:

1. List several ways transportation systems impact our environment (good and bad).
2. Discuss how the environment and transportation can coexist.
3. Explain the interrelationship of pollution, transportation, and society.
4. Explain how economics is related to environmental impacts.

CALENDAR

DAY	ACTIVITY
1	Lecture and discussion on: A. Environmental factors 1. Human/social 2. Economic/service 3. Physical and functional 4. Aesthetics 5. Interrelated 6. Ecological. Film/Audio?
2	Students are to analyze their developed transportation system in regard to environmental factors.
3	Students are to present report to class. Review and discuss findings, observations.

PRESENTING THE MODULE

DAY	ACTIVITY
0	Well before introducing this module, the following tasks should be completed: 1. Select and order film/video for Day 1. 2. Develop worksheets for film/video. 3. Develop worksheets for analyzing environmental impacts of systems.
1	Present a lecture and discussion on: A. Environmental factors 1. Human/social 2. Economic/service 3. Physical/functional 4. Aesthetics 5. Interrelated 6. Ecological. It should be noted that environment in this case is more than just "nature." It involves all of those elements which create our surrounding environmental envelope. Nature or ecological impacts are the most widely discussed, however, they make up only a very small part of our total "environment." Concepts like the following should also be brought out: 1. Short-range impacts 2. Long-range impacts 3. Chain reaction impacts 4. Energy use/dependency 5. Private vs. public rights 6. Government controls/influences. Show films, videos, slides to reinforce ideas and concepts.

DAY	ACTIVITY
2	Students are to analyze the transportation system model developed in the "system types" module in regard to six environmental factors, and report on the tie with each area including improvements, changes, problems, etc. which should/could be done. Some concepts and thoughts to add are: 1. Short-range impacts 2. Long-range impacts 3. Energy use/dependency 4. Land/space use/need 5. Private rights vs. public rights 6. Government controls/influences. Students should record notes and information in their notebooks.
3	Have students present reports to the class and include all findings, observations, and thoughts. Discuss observations and thoughts. Review concepts covered.

APPENDIX

SAMPLE FILM WORKSHEET

Student's Name: _____

Transportation System: _____

Impact: _____

_____

_____

_____

Transportation System: _____

Impact: _____

_____

_____

_____

Transportation System: _____

Impact: _____

_____

_____

_____

APPENDIX

SAMPLE SYSTEM ANALYSIS WORKSHEET

Student's Name: _____

Transportation System: _____

Human/Social Impact: _____

Economic/Social Impact: _____

Physical/Functional Impact: _____

Aesthetics: _____

Interrelated Areas: _____

Ecological Impact: _____

BIBLIOGRAPHY

Films/Videos

Free Loan Films